

# Benefits of Microgreens: How are Microgreens Effective in Boosting Immunity and Protecting against Cancer?

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## ABSTRACT

Microgreens are tiny, edible greens that have gained a lot of popularity in the past few years. Grown from the seeds of vegetables and herbs, not only do they add intense flavor, vivid colors and a crisp texture to dishes, but they also are extremely nutritious. Although they are only a few inches tall, studies show that they pack forty times the nutritional value of their mature counterparts.

Microgreens are rich in nutrients and pack an abundance of phytonutrients like vitamins B1, K1, and C, carotenoids, minerals as well as antioxidants which are known to improve immunity and have protective benefits against cancers.<sup>1</sup>

The following is a research study on the nutritional benefits of microgreens and how effective they are in protecting against chronic diseases like cancer. It is a compilation of studies and articles from notable medical journals and organizations to delve deeper into the effectiveness of microgreens.

**KEYWORDS:** Biomedical and Health Sciences; Nutrition and Natural Products; Immunity; Cancer-Protection; Nutrients; Microgreens

## INTRODUCTION

Microgreens are young, tender vegetable greens that are approximately 1-3 inches tall. They are produced from the seeds of vegetables and herbs, and are harvested 7-14 days after germination, when they have two fully developed cotyledon leaves. Often called "vegetable confetti," they are used to enhance the color, texture, or flavor of different foods, attributing to their intense aromatic flavor and variety of colors and textures. They are also packed with a number of vitamins, minerals and antioxidants.

Microgreens have over 25 varieties, including arugula, basil, kale, broccoli, mustard, cilantro and beet. Studies show that microgreens contain ascorbic acid (vitamin C), phyloquinone (vitamin K1), tocopherols (vitamin E), phytonutrients like vitamins B9, the carotenoids (lutein, violaxanthin, zeaxanthin and  $\beta$ -carotene),<sup>1</sup> and minerals like potassium, calcium, magnesium, manganese, copper, zinc, iron, sodium, and selenium.<sup>2</sup> They also pack many antioxidants. According to research, they pack forty times the nutrition content of their mature counterparts. Epidemiological studies have shown that their high nutrient content is associated with boosting immunity and preventing and curing chronic diseases like cancer.<sup>1</sup>

Microgreens also have immense positive effects on the environment. Environmental sustainability is one of the most important factors of crop production. Microgreens are sustainable because they can be grown with little to no equipment, either using some soil or hydroponically, in the

comfort of one's home. Experimental data also indicates that broccoli microgreens, for example, need 158–236 times less water and 93–95% less time than a nutritionally equivalent amount of mature vegetable needs to grow fully.<sup>2</sup> The microgreens also require fertilizers, pesticides, or energy-demanding transport from farm to table. This makes them very environment-friendly and easy to grow.

## Results and Discussion

One-third of the world's population is overweight and/or undernourished.<sup>3</sup> This problem roots at the lack of nutritious food. A very serious problem which is prevalent in both developed and developing countries is "mineral malnutrition with over 60% and 30% of the World's seven billion people, being Fe and Zn deficient, respectively."<sup>3</sup>

According to the 2018 World Hunger and Poverty Facts and Statistics, "the Centers for Disease Control and Prevention estimates that as many as 2 billion people worldwide, about half of whom are children, are not getting enough nutrients, such as vitamin A, iron or zinc, in their diets."<sup>4</sup> Dr Francesco Branca, Director of the Department of Nutrition for Health and Development at the World Health Organization (WHO), says that "nutrition is the main cause of death and disease in the world."<sup>4</sup>

## Nutrient Content of Microgreens

Microgreens is the emerging crop which can serve as a dense source of nutrition that can be grown in any part of the world with minimum to no equipment. Gene Lester, a

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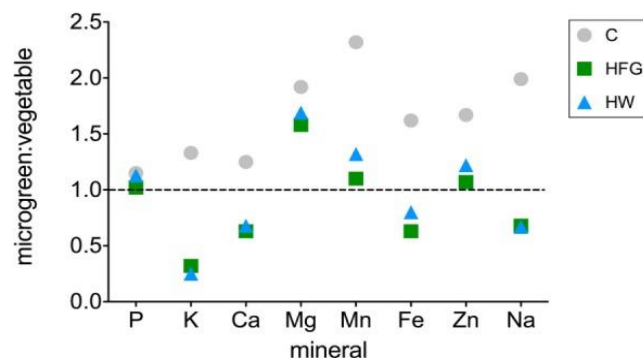
researcher at the U.S. Department of Agriculture, and his colleagues at University of Maryland, College Park, conducted a research study to measure the nutritional content of microgreens. The researchers analyzed the concentration of four groups of vitamins and other phytochemicals in 25 varieties of microgreens. Phylloquinone, or vitamin K, was found in great quantities in garnet amaranth (4.1 µg/g FW), green basil (3.2 µg/gFW), and red cabbage (2.8 µg/gFW) microgreens.<sup>1</sup> On the other hand, according to the USDA national nutrient database, phylloquinone concentration in mature amaranth, basil, and red cabbage were 1.14, 0.41, and 0.04 µg/gFW, which are much lower than the values for their corresponding microgreens.<sup>1</sup> Red cabbage was highest in vitamin C, while the green daikon radish microgreens had the most vitamin E. Other nutrients like ascorbic acid (vitamin C), carotenoids, and tocopherols, all associated with “reduction in the development of chronic disease, such as cancer and cardiovascular disease”, were four to six times more concentrated in microgreens than the mature leaves of the same plants.<sup>1</sup>

microgreen name	TAA (mg/100 g FW)	FAA (mg/100 g FW)	DAA (mg/100 g FW)
arugula	45.8 ± 3.0	32.7 ± 1.3	13.2 ± 2.8
bull's blood beet	46.4 ± 3.0	46.0 ± 3.3	0.5 ± 0.3
celery	45.8 ± 3.1	32.6 ± 1.3	13.2 ± 2.8
China rose radish	95.8 ± 10.3	73.2 ± 3.4	22.6 ± 7.4
cilantro	40.6 ± 2.4	24.5 ± 1.8	16.1 ± 2.2
garnet amaranth	131.6 ± 2.9	105.1 ± 3.1	26.5 ± 1.4
golden pea tendrils	25.1 ± 0.7	15.3 ± 1.7	9.8 ± 1.2
green basil	71.0 ± 2.7	59.0 ± 1.8	12.0 ± 1.1
green daikon radish	70.7 ± 2.7	58.8 ± 1.7	11.9 ± 1.1
magenta spinach	41.6 ± 0.8	36.0 ± 0.8	5.6 ± 0.2
mizuna	42.9 ± 1.6	32.3 ± 1.0	10.6 ± 0.7
opal basil	90.8 ± 2.7	81.8 ± 1.6	9.0 ± 2.0
opal radish	90.1 ± 2.7	81.1 ± 1.7	9.0 ± 1.9
pea tendrils	50.5 ± 0.9	27.9 ± 1.1	22.5 ± 0.3
peppergrass	57.2 ± 1.6	33.0 ± 0.7	24.2 ± 1.8
pop corn shoots	31.8 ± 0.7	21.4 ± 2.5	10.4 ± 3.0
purple kohlrabi	62.8 ± 7.3	48.1 ± 3.7	14.7 ± 3.7
purple mustard	72.1 ± 4.6	53.6 ± 2.6	18.5 ± 4.4
red beet	28.8 ± 0.4	27.5 ± 0.3	1.3 ± 0.5
red cabbage	147.0 ± 3.6	103.3 ± 9.0	43.7 ± 5.4
red mustard	62.2 ± 2.6	40.8 ± 1.4	21.4 ± 1.3
red orach	45.4 ± 0.9	43.7 ± 0.9	1.7 ± 0.2
red sorrel	56.7 ± 1.4	41.9 ± 1.9	14.9 ± 0.7
sorrel	20.4 ± 0.5	17.9 ± 0.3	2.6 ± 0.2
wasabi	44.8 ± 1.9	35.0 ± 2.0	9.8 ± 0.1

**Table 1. Mean Total Ascorbic Acid (TAA), Free Ascorbic Acid (FAA), and Dehydroascorbic Acid (DAA) Concentrations in 25 Commercially Grown Microgreens<sup>1</sup>**

Carolyn F Weber, in the Journal of Horticulture, has conducted a study comparing the nutrient content of lettuce and cabbage microgreens to that of store-bought mature cabbage and lettuce. The findings show that the microgreens are much more nutritious than their mature counterparts. She found that “the average ratios across the 10 nutrients (P, K, Ca, Mg, S, Mn, Cu, Zn, Na, and Fe) indicate that LC, LHP, CC and CHP were 2.8, 2.7, 8.1 and 2.9 times more nutrient-rich than the mature vegetable.<sup>2</sup> Particularly high nutrient ratios were observed for Fe in cabbage microgreens with CC having 54.6 times the amount of Fe as the mature vegetable, while CHP had 5.4 times the amount of Fe as the mature vegetable.<sup>2</sup> For Fe, lettuce microgreens still contained between 2 and 3 times the amount as the mature vegetable, but it is clear that cabbage microgreens are able to acquire far greater amounts of Fe when grown on the same

substrates. For Zn, cabbage microgreens contained between 5 and 7.5 times the amount of Zn as the mature vegetable.”<sup>2</sup>



**Figure 1. Broccoli microgreen:vegetable mineral ratios for microgreens grown on compost (C), or hydroponically (HFG), or with water only (HW)<sup>2</sup>**

### Immunity Boosting and Cancer Protective Properties

Microgreens have high nutritional content and it is for this reason that they have immunity boosting properties. Epidemiological studies in the National Library of Medicine have shown that consuming essential nutrients like vitamin C, vitamin K1, provitamin A compounds, and vitamin E from fruits and vegetables is associated with higher protection from chronic diseases like cancer. The World Cancer Research Fund recommends that we consume at least 600 grams of fruits and vegetables per day. Microgreens can serve as the perfect solution – they are a dense source of essential vitamins and minerals. They protect the body by going to the root and building immunity in the cells so as to prevent chronic disease.

Broccoli microgreens have known to have great cancer protective properties – they are very often called a superfood. According to a study conducted by Paul Talalay of the Johns Hopkins School of Medicine, crucifer sprouts like broccoli microgreens are able to induce 10-100 times more carcinogen protective enzymes than larger quantities of mature vegetables.<sup>5</sup> Broccoli microgreens are known to be rich in sulforaphane, which has anti-cancer effects against prostate, breast, and urinary cancers.<sup>5</sup> Sulforaphane is a compound which binds to a protein inside cells increasing the production of enzymes which resist carcinogens. Broccoli microgreens also contain many bioactive compounds, such as flavonoids and phenolic acids including gallic, chlorogenic, ferulic, sinapinic, benzoic, and salicylic acids, quercetin, kaempferol, vitamin C and glucosinolates, which have shown anticancer activity.<sup>5</sup>

Stephanie Tortorella and colleagues also found tumor cells with “stem cell-like self-renewal capacity that may be responsible for relapse, metastasis, and resistance, as a potential target of sulforaphane and may be an important aspect of sulforaphane chemoprevention. Evidence also suggests that sulforaphane may target the epigenetic alterations observed in specific cancers, reversing aberrant changes in gene transcription through mechanisms of histone deacetylase inhibition, global demethylation, and microRNA modulation.”<sup>6</sup>

Research also indicates that sulforaphane inhibits breast cancer stem cells. The study conducted by Yanyan Li and colleagues showed that sulforaphane eliminated breast CSCs, thereby abrogating tumor growth, and also down regulated the Wnt/beta-catenin self-renewal pathway.<sup>7</sup> These findings reaffirmed the use of sulforaphane for the chemoprevention of breast cancer stem cells.

John W. Finley, at the U.S. Department of Agriculture, along with other researchers, has also conducted a study about the cancer-protective properties of high-selenium broccoli. They found that the Selenium from high-Se broccoli microgreens reduces and protects against chemically induced colon cancer in rodents, which was then transferred to humans.<sup>8</sup> Fuente, García, Máñez, Alegría, Barberá, and Cilla at the University of Valencia, Spain also conducted a study about the antiproliferative effect of microgreens on human colon cancer cells. They found that the antioxidant bioactive compounds present in four hydroponic Brassicaceae microgreens (broccoli, kale, mustard and radish) reduced the proliferation of tumoral cells in the human body.<sup>9</sup>

Many other microgreens also have anti-cancer properties. Chickpea microgreens contain anti-cancer compounds called isoflavones, which have shown a remarkable inhibiting effect on the growth of breast cancer cells. A study conducted at Jagiellonian University has shown that the rutabaga microgreens have a high antioxidant content and anti-cancer properties.<sup>10</sup> Researchers at the North Dakota State University have found that flaxseed microgreens induce cell death on human breast cancer cells.<sup>10</sup>

All these microgreens have shown a positive effect on inhibiting the growth of cancer cells. This is just the start. There are many other varieties of microgreens and continued scientific research on the benefits of microgreens will only help in bringing their importance to the public eye.

### Conclusion

It suffices to say that microgreens are highly concentrated sources of essential nutrients, along with being environment friendly. They help build body immunity, which in turn is linked with protection from diseases, including cancer.

While all this is true, it is required to mention that microgreens have not been explored to its full potential yet. Further research needs to be conducted to realize their extensive benefits fully. The available research shows promising results, but only further exploration can bring forth all the benefits of microgreens. While eating a highly nutritious, and nutritionally dense, plant-based diet does stimulate the immune system, which impacts the on-set or development of cancers and human health in general, that's about all there is scientifically about plant-based foods and human cancers at this point in time. Most of the available studies have been conducted in Vivo on cell lines. However promising, further invitro research will be able to fully describe the relationship between microgreens and human cancers.

Nutritionists advise us to eat more fruits and vegetables because observational studies consistently find an association with less cancer. However, this also needs to be taken into context, as people eating the most fruits and vegetables also don't smoke, they exercise more, aren't obese and maintain regular medical check-ups. Fruits and vegetables help maintain a healthy lifestyle, and microgreens are an easy addition in maintaining a healthy life.

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Swaraj Agarwal is a senior in high school at La Martiniere for Boys, Kolkata, India. He is passionate about the intersectionality of sociology, economics, public health, and environmental science, and hopes to pursue these interests in college. He runs Micro Treasures, a social enterprise aimed at creating awareness about and supplying microgreens.